

Ultrasound Measurement of Femoral Anteversion and Tibial Torsion (**CZG 4/1/6**)

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This project aimed to establish a method of measuring femoral anteversion and tibial torsion using real time ultrasound images and a new system of electronic inclinometry. The inclinometry system was carefully calibrated and proved accurate to within 1 degree and precise to within 0.2 of a degree. Individual inclinometers were attached firmly to both a 5MHz and a 7.5MHz linear array ultrasonic transducer using a specially produced clamp which gripped the front and rear of the probe head. Two low profile flexible switches linked by wire to a data collection computer were used to start and stop recording of the output of the inclinometers at 50Hz.

The measurement technique itself involved obtaining a real time image of proximal end of the bone under examination. A reference line linking two points on two key anatomical structures was then observed visually. The head of the ultrasonic probe was then rotated until the reference line linking the anatomical points was horizontal on the ultrasound screen and a recording of the angle of the probe to vertical was taken. Then keeping the leg immobilised and correctly positioned the probe was moved to the distal end of the bone and the process repeated. The rotation (torsion) of the long bone was then calculated by taking the difference in readings between the proximal and distal ends of the bone.

The concurrent validity of the ultrasound measurements was assessed in comparison with direct measures using cadaveric femora and tibiae. Each bone was divided mid shaft and mounted on a rig that will allowed axial rotation of each component. To mimic the soft tissues the bones were encased in a set gelatine compound contained in a plastic bag. Long bone rotations from +60 to -30 degrees in 10-degree increments were applied. The data indicated that the technique could measure the angular rotation to within +/- 6 degrees in 95% of cases (SD 3 degrees).

Intra-observer reproducibility of the measurements was assessed on 34 adult volunteers and 16 children. On each test occasion the left and right, femoral anteversion and tibial torsion of the subject was measured twice. Adults were tested on two occasions separated by a week and children on one occasion. The data showed good agreement with other published studies using imaging techniques. Differences between individuals were large however repeated measures on individuals were highly consistent. The measurement technique therefore has the ability to monitor the progress of individual subjects undergoing treatment. The technique could detect true clinical changes of the order of 10 degrees between two repeated measures which is clinically suitable. If a series of measures were taken including baseline measures before intervention a much greater precision in assessing clinical change would be possible. ICC values for adult were generally good while those for children were high.

It was concluded the inclinometer system is accurate and precise and that the values obtained with the new ultrasound technique show good concurrent validity with direct measurement of dry bones set in a tissue mimicking medium. The ultrasound technique has sufficient reliability to be used clinically to monitor the long bone rotation of individual subjects. The data confirmed that femoral anteversion and tibial torsion are highly variable between adults and children as reported by other

researchers using different techniques. The ultrasound and electronic inclinometer system offers a scientifically suitable alternative to other imaging methods of measuring long bone rotation and is both acceptable to subjects and practical to implement. The new method offers a cost effective and ethically more acceptable alternative for monitoring long bone rotation over a period of time than either CT or MRI scanning.